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Update on the herpetofauna of Syros (Cyclades, Greece) and current land-use and climate change threats

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Abstract

The current knowledge on the herpetofauna of Syros is updated, whereby no publications on it have been made since 1975. I provide the results from a field trip in 2024 that focused on the hygrophilous species. The Balkan Water Frog and the Balkan Terrapin, mentioned for Syros in the 19th century, meanwhile have become extinct. The Green Toad is threatened with extinction, the status of the Grass Snake is unclear. The Green Toad has benefited previously from anthropogenic spawning grounds in the form of open cisterns, which have fallen into disuse and thus are no longer available to the amphibians. The ongoing climate change in the Aegean region is reflected in drier winters, which dry out water bodies. The situation for the wetlands and their fauna and flora on Syros is alarming.

Key Words

conservation, hygrophilic herpetofauna, status, wetlands

Island portrait

Syros, also known as Syra in older spellings, lies in the middle of the Cyclades Archipelago. Its area is 84 km^2, with Pyrgos peak reaching 442 metres above sea level. With its 21,500 inhabitants (2011), it is the most populous island in the Cyclades, and includes Ermoupoli, the administrative centre for the southern Aegean region. The island is divided into a largely uninhabited, treeless northern half (Fig. 1) and a more intensively used and urbanised southern half.

Historical and subrecent data on the herpetofauna of Syros

There has been no dedicated study on the amphibians and reptiles of Syros, and no field herpetological results have been published on this island for almost 50 years. Bedriaga (1882) mentions the occurrence of the Balkan Terrapin (*Mauremys rivulata*) and the Balkan Water Frog (*Pelophylax kurtmuelleri*) on Syros. These were my incentives to visit the island and check for possible occurrences.

The first herpetological references to Syros go back to Theodor Erhard's Fauna of the Cyclades (Erhard 1858). Bedriaga (1882, p.7, 14) describes Erhard's contribution as erroneous; he is said to have confused species and islands in his work.

Fifty-six years later, Werner (1938) recorded eight species of amphibians and reptiles on Syros. He also adopts "*Clemmys caspica*" and refers to Bedriaga (1882). The most intensive herpetological work on Syros was done by Frör and Beutler (1980). The authors visited Syros in 1974 and 1977 and were able to evaluate additional herpetological collections (especially parts of Buchholz and Gruber and Fuchs collected materials, kept in the museums of Bonn, München and Vienna). Beutler and Frör (1980) provide an overview of the amphibians and reptiles found on the northern Cycladic islands (table 2 in their work). They consider the Syros herpetofauna to belong to the Central Cyclades. Overall, 13 species are listed in Beutler and Frör (1980) for Syros.

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Figure 1. Largely uninhabited north of the island Syros with Phrygana and very dry.

Unpublished personal data

There were three of us on our daily excursions. We visited Syros from 3–16 April 2024 with an overnight stay in Kini (former Kinion) on the west coast. During our stay on the island, the weather was mostly sunny, with air temperatures around 18–21 °C in the daytime and around 8 °C at night, mostly windy but occasionally stormy. We visited the whole island by car and on foot. In Kini, the area was also searched at night for the Green Toad. Of the 13 species recorded on Syros, we were only able to identify six. Below I provide a species list, including references to published data and specific data from this field sampling.

Bufotes viridis (Laurenti, 1768) European Green Toad

Bedriaga (1882, p. 65) writes: "In mid-March 1880, despite the cold weather, I already found adult tadpoles of *Bufo variabilis* on Syra". It was confirmed by Beutler and Frör (1980) for the areas of Kinion, Posidonia, Hermoupolis. We found only tadpoles on 10 April in Posidonia (37.38611°N, 24.88917°E). Further occurrences could not be detected (see details for this species later).

Pelophylax kurtmuelleri (Gaida, 1940) Balkan Frog

Bedriaga (1882, p. 55) states: "*Rana esculenta* is not missing anywhere on all Greek islands"; the water frog is also mentioned for Syra but without locality information. Beutler and Frör (1980) note: "Whether the species still occurs on Syros today must appear questionable, in any case we have not been able to find it there". We did not observe this species. According to our investigations, the species must be considered locally extinct.

Mauremys rivulata (Valenciennes, 1833) Balkan Terrapin

For the Balkan Terrapin (*Mauremys rivulata*), Bedriaga (1882, p. 188) notes: "I have encountered large numbers of this turtle species everywhere in the Cyclades". It is just mentioned for Syra. Beutler and Frör (1980) mentioned: "*M. rivulata* may already be extinct on Syros. At least it has not been observed for a hundred of years", but still included it on their list. Our lack of observations suggests that *M. rivulata* is locally extinct.

Mediodactylus kotschyi (Steindachner, 1870) Kotschy's Gecko

Bedriaga (1882, p.86), Erber (1866), von Oertzen after Boettger (1888), and Werner (1937) all list it without specific locations. Beutler and Frör (1980) observed it in a dry stream 1 km north of Kinion and in the surroundings of Hermoupolis. During our survey it was widespread, especially in the many stone walls, under stones and in fountains, where we found *M. kotschyi* especially in the north more than 20 times. I had the impression of seeing this species more often on smaller Aegean islands than on larger ones.

Hemidactylus turcicus (Linnaeus, 1758) Mediterranean House Gecko

Bedriaga (1882), Gruber and Fuchs in Gruber (1974) as well as Beutler and Frör (1980) note its occurrence in the surroundings of Hermoupolis and 1 km north of Kinion. We did not encounter it, despite searching in many wells and stone walls and on houses.

Lacerta trilineata (Lantz & Cyren, 1920) Balkan Green Lizard

Bedriaga (1882, p. 101), Boulanger after Boettger (1888) and Beutler and Frör (1980) list it occurring between Kinion and Hermoupolis and Posidonia, as a confirmation of Bedriaga. Beutler and Frör (1980) mentioned: "It is rare on Syros, which is probably due to the intensive agriculture use and the high volume of traffic". Our search was unsuccessful at all the stone walls. Only once, on 15 April 2024, an individual crossed the road near the top of the pass between Ermoupoli and Kini (37.44528°N, 24.92167°E).

Podarcis erhardii (Bedriaga, 1882) Aegean Wall Lizard

Bedriaga (1882, p.124) and Werner (1937) provided no specific locations; Beutler and Frör (1980) mention it from a dry stream at Hermoupolis and from Kinion, Posidonia, and Galissas. According to our observations this lizard was omnipresent on the island during our survey, making it the most common reptile.

Ablepharus kitaibelli (Bibron & Bory St. Vincent, 1833) European Snake-eyed Skink

Bedriaga (1882, p.73), Erber (1866), Beutler and Frör (1980) all mention its presence south of Hermoupolis. We found it several times in the leaf litter of the Phrygana in the north of the island. We encountered it on 4 April 2024 in the southern part only once in Dolphini Bay and on 5 April on the footpath to the cave church of Agios Stephanus near Galissas (37.41361°N, 24.87667°E).

Dolichophis caspius (Gmelin, 1789) Large Whip Snake

Clark (1969) included it without location, it was not seen by Beutler and Frör (1980). We encountered subadults on 6 April 2024 on the footpath from Kambos to the northern tip of the island near the Kanavoria field not far from the old marble quarry and also in the north near Syrigas on 8 April 2024. This was a confirmation of its initial discovery by Clark (1969).

Zamenis situla (Linnaeus, 1758) Leopard Snake

Erber (1866) and Clark (1969) observed it, but did not provide locations. Beutler and Frör (1980) mentioned its presence in a collection (Material Buchholz ZFMK, Museum Alexander König, Bonn), but it was not seen by them or us.

Natrix natrix persa (Pallas, 1814) Eastern Grass Snake

Von Oertzen after Boettger (1888) observed it but provided no location, Beutler and Frör (1980) recorded it in Posidonia, Kinion, Galissas, and state "In the North Cyclades *N. natrix* has only been observed near the water. The populations are now highly endangered due to ongoing habitat destruction". We did not find any *N. natrix* on the island. A spring is marked on the Skay map Nr. 305 north of Ermoupoli in the gorge area near Aghios Athanasios, which we identified as an older spring catchment. The landowner Nikos Monoryios confirmed to us that water used to flow there in the spring and he had seen snakes in the water there 10–15 years ago. This report supports a possible former occurrence of the Grass Snake. The current situation is unknown, the concerned biotopes of wetlands or streams are missing today on the island.

Telescopus fallax (Fleischmann, 1831) European Cat Snake

Clark (1969) observed it but provided no locations, it was not seen by Beutler and Frör (1980). We did not encounter it.

Vipera ammodytes (Linnaeus, 1758) Nose-horned Viper

Beutler and Frör (1980) mentioned for Syros Oertzen after Boettger (1888), material of Buchholz and Clark (1969) without locations. Beutler and Frör (1980) saw *Vipera ammodytes* in the surroundings of Hermoupolis. We encountered four individuals, all relatively small, i.e. 35–45 cm long. The first approx. 35 cm long and light brown coloured specimen was observed on 5 April on a rocky embankment from Chroussa to Agios Paghos near the church of Panaghia Faneromeni in the southern half of the island (37.41056°N, 24.92028°E). On 6 April, we found a fresh roadkill in the north of San Michaelis (37.49000°N, 24.91833°E). Another live specimen was seen near Kambos on 8 April (37.49639°N, 24.91694°E). Finally, a live individual about 35 cm long was found on 14 April on the roadside at the top of the pass from Ermoupoli to Kini (37.44528°N, 24.92167°E).

Unsuccessful search for wetlands

A particular focus of our visit was the search for wetlands. Beutler and Frör (1980, p. 257) found no large wetlands on Syros. They found smaller bodies of water at Posidonia, Ghalassas and Ermopoulis. In the inventory of wetlands on Greek islands (WWF 2014), only two inventory objects are designated for Syros (Fig. 2). SYR 001 "Estuary of Varvaroussa Beach" is located nearby Kini (37.46861°N, 24.89694°E). On 12 April, only a remnant of a brackish backwater measuring approx. 10 m^2 was still present there (Fig. 3). SYR 002 "Ghalissas Bay" is located west-northwest of Ghalissas and should also include a brackish backwater on 1.18 ha (37.42083°N, 24.87777°E). During the site visit on 5 April, there was no surface water at all, only remnants of a reed bed were still present (Fig. 4). The wetland inventory protocols do not contain any further natural history information including about amphibians.

Figure 2. Map of Syros with indication of WWF objects wetlands and former and present occurrence of the Green Toad. Map source: WWF Greece 2014.

Figure 3. Estuary of Varvarousa Bay in WWF-Greece wetland inventory.

Figure 4. The former wetland in Ghalissas Bay as indicated in WWF-Greece wetland inventory.

The estuaries of somewhat larger catchment areas into the sea were specifically investigated, as were all the spring locations included in the Skai map (no. 305 Syros; scale 1:20 000). These were either captured or have dried up. We saw flowing water (a short open sewer that flowed into the bay) only in the southern industrial area of Ermoupoli

Water scarcity and the effects of climate change

In the southern half of the island, the demand for water is high due to the intensive vegetable and horticultural plantations. No other Cyclades island has had such a dense network of cisterns and so many groundwater wells. However, many of the open cisterns are no longer in use. The groundwater in the wells, which are also no longer active, can be found at an estimated depth of 8–10 m.

In the summer months, the ecological system suffers under the drought. The influx of tourists temporarily doubles the population. Water consumption on Tinos increases from 1,500 cubic metres to an average of 2,700 cubic metres per person per day; the situation is similar on Syros. Drinking and processed water comes from the sea, 95% of which is treated in desalination plants. There is also a lack of infrastructure, such as piping, to utilise the purified water (Papasozomenou 2017).

Climate change effects are not manifested uniformly worldwide. In the Mediterranean, an increase in dry winters is noticeable (data from ERAS, fifth generation atmospheric analysis of global data, covering 1979–2021 with a spatial resolution of 30 km (www.meteoblue.com/de/wetter/archive/export/syros_griechenland2537; accessed on 9 Oct 2024).

The average temperature has increased by 1.6 °C. since 1979 (Fig. 5). The average annual precipitation in the period 1979–2023 was 289 mm. The years 1981, 2003 and 2019 were wetter but since 2020 it has remained consistently dryer (Fig. 6). During our stay on the island, we did not find any surface water in the dry streams that carry water during heavy winter rainfall. Water can usually be found in a normal year in siphons in rocky pools or as backwater at the mouths of the streams. These changes in weather have a massive impact on the hygrophilic herpetofauna, as has already been described for the island of Ios (Broggi 2023). The impacts are described below for two species of herpetofauna for Syros.

On the occurrence of the Green Toad (*Bufotes viridis*)

It has been very dry in recent years, as confirmed by our own observations in 2024. We could not find available natural biotopes on Syros as spawning sites for Green Toads. Open cisterns are sometimes accessible for the reproduction of the Green Toad, as was shown for the Cycladic island of Kythnos (Broggi 2021). The numerous open cisterns on Syros have also been used historically as alternative spawning grounds by the toads

The three locations of the Green Toad in Kini, Ghalissas and Ermopouli mentioned by Beutler and Frör (1980) were searched (Fig. 2) intensively, especially during the overnight stay in Kini. At Kini only two open cisterns

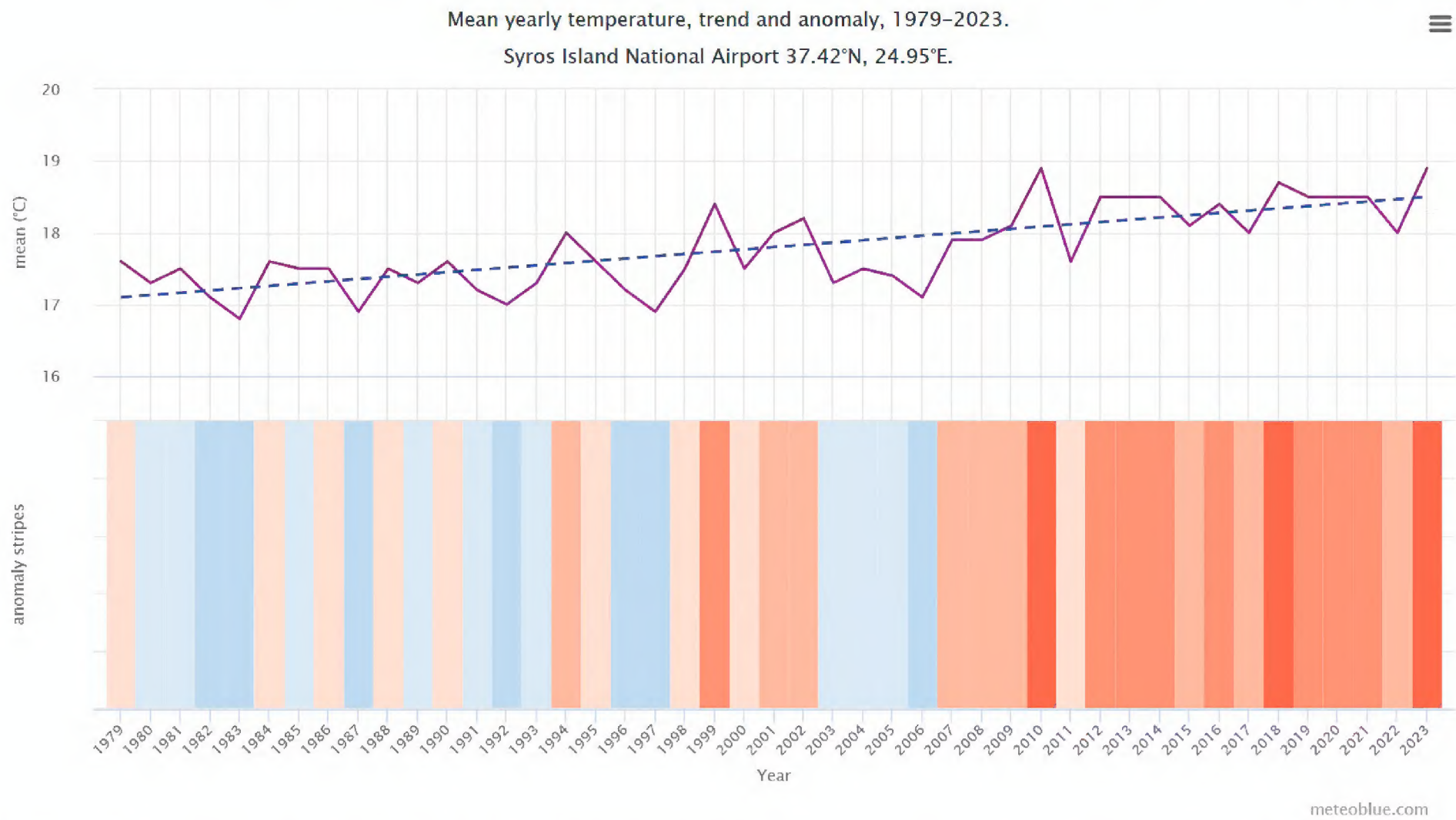

Figure 5. Mean annual temperature in Syros 1979–2021. The dashed blue line is the linear trend of temperature change. The stripes in the lower part of the graph indicate deviations from the mean, with blue for colder and red for warmer years (Data from: www.meteoblue.com/de/wetter/archive/export/syros_griechenland2537; accessed on 9 Oct 2024).

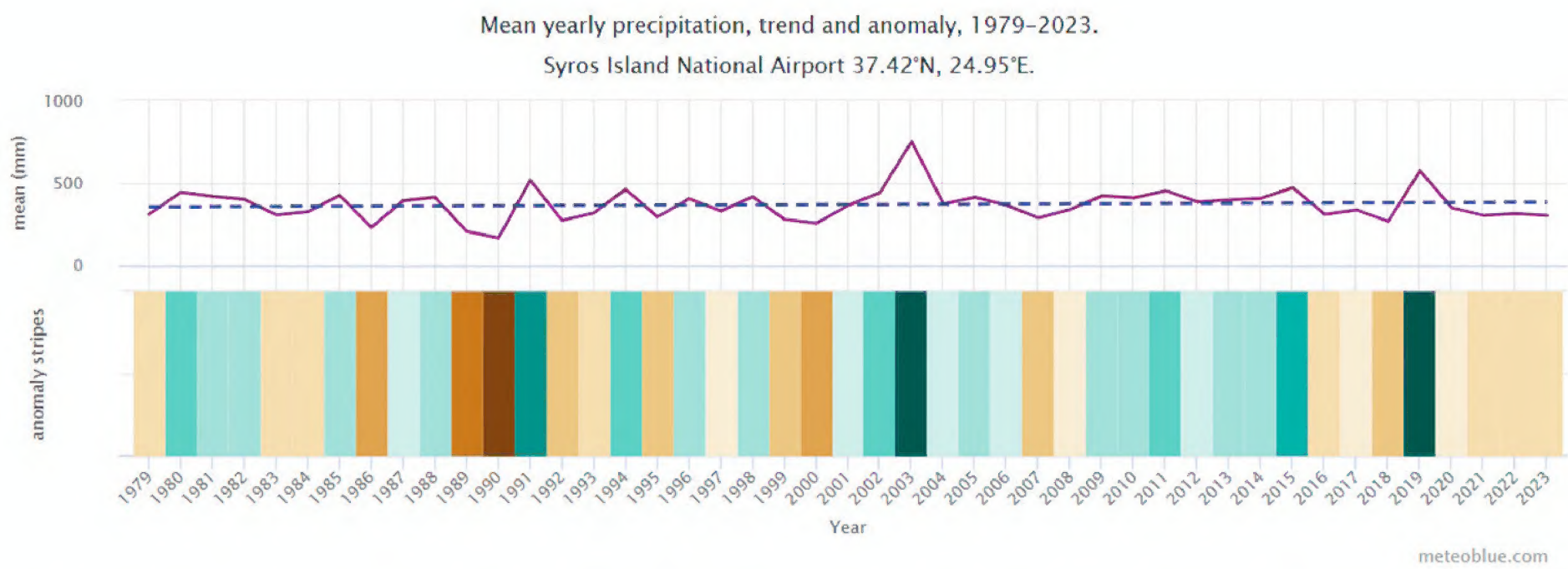

Figure 6. Annual precipitation in Syros 1979–2021. The stripes in the lower part of the graph indicate deviations from the mean, with green for wet and brown for dry years (Data from: www.meteoblue.com/de/wetter/archive/export/syros_griechenland2537; accessed on 9 Oct 2024).

Figure 7. Open cistern with water but also Goldfish.

filled with water were found to be possible spawning sites for the Green Toad. However, Goldfish (*Carassius auratus*) were found in these tanks. The spawn of amphibians is eaten by the Goldfish, especially if there is no protection by vegetation. Goldfish were also found in several other cistern sites in the south of the island (Fig. 7). Benefits for people from these Goldfish are hard to conceive, whereas the harm to the amphibians is immense. Coexistence between fish and amphibians is possible, but depends on the presence of shallow water zones with riparian vegetation (Laufer and Wollenzin 2011). This is not the case with cisterns.

The intensive search for the Green Toad on 10 April led to an open cistern in the middle of Posidonia with a basin size of approx. 12 × 12 metres (37.38611°N, 24.88917°E). Well-developed tadpoles of the Green Toad were found in it (Fig. 8). This remained the only island record. Evidently, the Green Toad on Syros is threatened with extinction.

These general conditions also indicate why the Balkan Frog (*Pelophylax kurtmuelleri*), mentioned by Bedriaga (1882) as occurring on Syros, can no longer be found on the island. Beutler and Frör (1980) described the then current occurrence of the water frog as "questionable".

Figure 8. Cistern in Posidonia with tadpoles of *Bufotes viridis* (37.38611°N, 24.88917°E).

On the possible occurrence of the Balkan Terrapin (*Mauremys rivulata*)

There is only a reference by Bedriaga (1882) for the occurrence of the Balkan Terrapin on Syros, unfortunately, without providing a location. Beutler and Frör (1980) stated that the Balkan Terrapin "may already be extinct". In the village of Hartiana in the north of the island on 7 April, we met two young Greeks with whom we struck up a conversation. They asked about our reason for visiting the island. When we asked about the possible presence of turtles, one of them surprised us by telling us that a friend had told him that he had seen turtles in a body of water in Sykaminia Bay below the hamlet of Kambos in the north of the island. He marked the possible location on the map, which was a few hundred metres above the bay. This made it impossible to confuse it with sea turtles. A search of the indicated location the following day gave no indication of such a possible habitat. Geologists encountered in the area confirmed that they had not seen any water surface in this area. How should this observation be interpreted? Was there still a relict population on the island in recent times? We cannot judge this, but believe that the location given is hardly possible for a long-standing water surface. From today's perspective, based on our own research, there is a lack of suitable habitats for the terrapin on the island. Still, the extinction of the Balkan Terrapin must be confirmed for Syros.

Figure 9. Abandoned cistern.

Conclusions

Four conclusions can be drawn for the current state of the hygrophilic herpetofauna on Syros:

1. Wetlands are naturally rare on the small Cyclades islands of less than 100 km^2 in size, as they usually lack larger hydrological catchment areas with water retention. Such habitats are usually only possible on a small scale, they are therefore vulnerable, very sensitive to external influences and the animal and plant species living in them are relictual in nature. Genetic exchange is hardly possible anywhere.
2. Due to their fragility, aquatic habitats are particularly at risk. For island wetlands, there are conflicts of use with agriculture and tourism. Agriculture is interested in suitable agricultural land where watercourses flow into the sea and has therefore cultivated wetlands. Agriculture development has utilised the watercourses that flow in winter and channeled the water through hoses into reservoirs and cisterns for irrigation of crops. Pumping also lowers the groundwater level. There is also a conflict of use in the estuary area of the dry streams with tourism, which is interested in utilising suitable sandy beaches.
3. While the natural habitats were impaired by increasing utilisation pressure, the hygrophilic herpetofauna was able to benefit in the past in part from the anthropogenic structures with the open cisterns. In the course of the ongoing structural change in agriculture, the maintenance of this complex irrigation regime is increasingly being dispensed with (Fig. 9). Groundwater pumps are being used or agricultural practices are being abandoned (Fig. 10). As a result,

Figure 10. Historic groundwater well out of operation.

these sub-optimal habitats are no longer available. Goldfish stocking in cisterns presents a further threat.

4. Climate change is noticeable through marked increases in temperature, but also manifests itself in drier winter months with a lack of the usual heavy rainfall. This contributes to a massive reduction in suitable habitats and prevents amphibians from reproducing. In the Cyclades elsewhere, amphibians such as the Balkan Water Frog (*Pelophylax kurtmuelleri*), the Green Toad (*Bufotes viridis*), the Common Toad (*Bufo bufo*) and the Tree Frog (*Hyla arborea*) are particularly affected. Among the reptiles, this also applies to the Balkan Terrapin (*Mauremys rivulata*), the Grass and Dice Snakes (*Natrix natrix* and *N. tessellata*) and, to a lesser extent, the Nose-horned Viper (*Vipera ammodytes*) and the Giant Green Lizard (*Lacerta trilineata*), which also prefer more humid structures.

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